UIT Concept Challenges

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Introduction

In the next few years, large and robust networks that aggregate distributed energy resources (DER) such as generators, flywheels, microturbines, fuel cells, photovoltaic technologies, wind turbines, and uninterruptible power supplies will gain marketplace acceptance. By design, DER assets are often sited on the fringes of a utility distribution network. While they are close to the point of energy consumption, DER assets are not necessarily in close proximity to each other or interconnected to a common energy delivery system. Interconnection of emerging DER technologies, particularly those that are inverter-based, will become increasing important to successfully create a robust marketplace for non-traditional generation and energy storage products.

Parallel interconnection to a utility energy delivery network is required to capture the full value of DER technologies. By design, a non-parallel installation can only create value if there is demand from a dedicated load. If a dedicated load source is idle, then the DER asset also remains idle and unable to take advantage of external events. Further, a parallel interface is vital to aggregate DER components sharing the same site. Without the ability to load share, DER assets cannot be dispatched in optimal sequences. Operators of DER assets will seek the ability to prioritize dispatch sequences based on a variety of factors including operational costs, maintenance history, fuel availability and emissions output. Fuel cells, microturbines, flywheels and other DER technologies require similar bridging technologies for synchronous operations.

The remote management of multiple DER technologies is a vital component in creating a truly robust network of DER technologies. Remote management often combines both hardware and software based solutions. Many of the existing hardware based devices that can determine if a DER is on or off but fail to provide safe and dynamic system control. Yet, from a managerial perspective, networking devices should include analytical software packages that integrate fuel price, energy tariff data, and other external market data as triggers to control DER networks in optimal sequences. The control networks will not manage the DER devices in isolation but rather integrate the DER technologies with utility SCADA systems, customer meters and enterprise level management platforms. In essence, end-users will eventually demand that fuel cells, flywheel, microturbines and traditional power generation technologies become fully integrated assets inside an enterprise level resources management system such as SAP.

Challenges

To create these robust networks while meeting the demands of the marketplace an aggressive research and development program undertaken by all DER stakeholders should continue. Without a universal interconnection technology (UIT) as an industry standard, end-users will not fully appreciate the benefits of DER technologies and some promising DER technologies may die on the vine without ever being fully commercialized.

Challenge #1 – Inverter technology integration

DC Interconnect Bus characterization/requirements

Inverter-based prime movers such as wind turbines, microturbines, fuel cells and photovoltaic technologies should share a common standard to interoperate with each on a common bus. Defining the DC power bus characteristics (voltage, transients, time to start generating power/maximum power output, current characteristics, time to increase/decrease power) of each of these technologies is vital for aggregation of multiple generation products. Defining the DC bus requirements interface of an inverter-based controller an important step in creating and understanding the interface to a robust UIT standard design.

Interconnecting multiple inverters

Work should continue to define the optimal aggregation scenarios for inverter-based technologies to eliminate potential redundancies. Evaluation is needed to focus on the ability to chain multiple inverters together to manage higher output inverter based systems. As an example, if a single inverter based controller is capable of handling a 50KV system, can two controllers be combined to manage a 100KV system? This technology evaluation should include the potential sizing of controller aggregation (25KW, 50KW, 100KW, and larger). Determining the optimum controller size for inverter-based technologies will aid in a UIT interface for inverter-based technologies.

Voltage support technologies required for inverter based technologies

As time delays are critical to consider for networked applications, a study of the various voltage support technologies (batteries, super capacitors, flywheels, etc) output capacities, charging capacities and power absorption technologies (for sudden load drop offs) are required to illustrate how these technologies can interoperate with fuel cells, photovoltaic and wind-based generation technologies. An analysis is required to determine the best control segmentation between voltage support technologies and other system controllers. Further work should evaluate load characteristics to offset sudden short-term voltage changes in an inverter-based system to aid in minimizing the size of the voltage support system. Defining a common interface for these technologies will greatly aid the UIT concept development.

Integration of Power Electronics and System control

Further research is necessary to develop requirements and implementation technologies associated with interconnecting inverter-based technologies. As inverter and synchronous machines use different interconnect technologies, yet the market will demand that these two technologies interoperate in seamless harmony. Further work should also be done evaluating the potential of common requirements of interconnecting both inverter and synchronous machines with the same technology. A volume-based cost analysis could determine if inverter based electronic relays have the potential to replace the current electro-mechanical relays used with generators. The evaluation should focus on the utility interconnection interface and technologies associated with a UIT approach.

Challenge #2 – Third Party Requirements

Business economics and size analysis

Similar to traditional generation technologies, the cost to parallel an inverter-based unit varies in cost with size. At a certain point, smaller units face high economic hurdles and the costs associated with interconnection become prohibitive for the majority of the residential, commercial and industrial customers. While niche market segments will seek to integrate small generators and storage devices with one another and the utility delivery system, serious consideration should be made to the disproportionately high costs of interconnecting these units with current technologies.

Site integration

Evaluation should be conducted to define the various types of devices that need to be interconnected for inverter and synchronous systems. The intent is to identify a common set of I/O technologies that would allow interconnections for site specific devices required by these two systems. This will define the common elements and features for a UIT based system.

Enterprise integration demands

Owners and users of various DER technologies will seek to integrate these assets with external third-party devices, legacy IT and communication systems and price signals from the emerging energy marketplace. To create a UIT standard interface, consideration should be given to the proper number and types of I/O ports required to interconnect DER devices with external data networks.

Next Steps & Recommendations

To make UIT feasible, marketplace realities must be accounted for. Clearly the energy delivery networks will be managed by utilities, RTOs and ISOs. When standards for interconnection are adopted, the first iteration such as IEEE P1547 is not enough. Enduring standards take time to create and utility stakeholders will remain influential. Development of new technologies is not enough. Significant policy challenges lie ahead. Further DG in general, and UIT in particular, must demonstrate new business models and value propositions to gain wide spread adoption.